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Applying State-level Approaches to Arms Control Verification

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Abstract

Reduction or elimination of nuclear arms is not likely to occur absent a lower perceived need for a nuclear weapons arsenal to support national security. Achieving such confidence on a national-level is the grand challenge. Lessons from verification of peaceful uses of nuclear fuel cycle activities by the International Atomic Energy Agency (IAEA) over more than 50 years has taught us that achieving confidence requires a coherent and comprehensive picture of the State's compliance with its obligations. This may be achieved by piecing together, in a well-structured way, a broad range of information encompassing declared, undeclared, international technical monitoring data, information from national technical means, open source, state-level, and international trade and diplomacy related to the material and capabilities under consideration.

The paper proposes a state-level analytical approach to be considered in developing future arms reductions initiatives based on the IAEA's State-Level Concept (SLC). The SLC outlines sequences of activities (cheating pathways) that a State could consider to acquire weapons usable material. It analyzes all plausible CPs aiming to determine whether a proposed set of safeguards measures will be sufficient. Mapping out the CPs is essentially producing a state-specific network of process and material and flows with identified nodes for inter-connections. The "relative attractiveness" of a CP, or usefulness in a nuclear weapons program, is considered in addition to the time it would take to implement such a process in a country.

The SLC might allow State-specific approaches to nuclear arms control with differentiation between States, taking into account all information available to the authorities and being responsive to the variations in risk of cheating. Similar to the IAEA SLC, the process could be implemented in three steps: (i) Identification of cheating pathways (CP), (ii) Specification and prioritization of State-specific technical objectives, (iii) Identification of verification measures to address the technical objectives. Initial consideration of using this methodology to verify nuclear materials in states possessing nuclear weapons is outlined. Suggested next steps for applying this approach for weapons are discussed.

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Introduction

The reduction or elimination of nuclear arms is not likely to occur absent a lower perceived need for nuclear weapons and high confidence that commitments are being honored. Over more than 50 years of IAEA verification has taught us that achieving confidence requires a coherent and comprehensive picture of the State's compliance with its obligations.

The traditional IAEA verification approach was based solely on the type and quantity of nuclear materials present in a state, without regard to other factors that correlate with proliferation risk. The State-Level Concept (SLC) was recently proposed as a way to increase the efficiency and effectiveness of safeguards. The SLC consists of the development of a state-level approach to identify areas of higher proliferation risk and the collection and evaluation of multi-source information, including safeguards information, to optimize future safeguards activities. By piecing together a broad range of information encompassing declared, undeclared, international technical monitoring data, information from national technical means, open source, state-level, and international trade controls, it may be possible to provide state-level confidence that commitments are being upheld. It takes into account broader State-level factors, potentially allowing greater focus on areas of higher risk of non-compliance. This approach could be extended to all types of treaty verification, including nuclear arms control and disarmament. So, in addition to verifying compliance for a particular treaty or agreement, such as the Nuclear Nonproliferation Treaty, it could be used to identify areas where effective verification could provide the greatest confidence that a State is complying with its commitments, and therefore help inform the most fruitful avenues for future arms reductions or disarmament efforts.

State-level analytical approach in development of future arms reductions initiatives

A state-level approach to verifying arms reductions needs to be objective, reproducible, transparent, standardized, and clearly documented. The IAEA SLC methodology (successfully demonstrated in the context of IAEA's SLC (Listner et al. 2012, Listner et al. 2013, Listner et al. 2014)) consists of three steps:

- Modeling of a cheating network and identifying cheating pathways. This is a purely technical assessment of attractiveness including technical difficulty, timing and costs;
- Determination of technical objectives, including identifying limits for detection probabilities for each area of a potential cheating network. It is assumed that requirements for high confidence verification result in the need for high detection probabilities for areas of highest risk; and
- Identification of the technical and administrative measures that would provide the required detection probabilities. This would be expanded beyond classical inspections and could include all types of measures related to the field of interest (e.g. information barrier approaches could be useful).

When there is an existing treaty or agreement, the legal commitments set out the context under which non-compliant behavior needs to be detected by the monitoring regime. Ultimately, these pathways should be developed to verify compliance with a specific set of treaty objectives and commitments. However, the methodology could be applied to a full range of assumed conditions, and therefore allow for a more general analysis. Following this approach, cheating pathways (CP) could be mapped out to produce a state-specific inter-connecting network of nodes and processes/flows for nuclear materials and weapons – beginning with more generic models to protect sensitive information. The “relative attractiveness” or usefulness in a particular nuclear weapons program CP would be considered. Timing is considered to be a component of assigning a level of attractiveness. It is recognized that expert judgment will be required where no data is available.

To achieve a state-level approach for arms control or disarmament, the methodology will need to take into account materials, weapons and the links between the two. Being that the IAEA SLC has been designed for implementation in Non-Nuclear Weapons States (NNWS) for verifying peaceful uses of nuclear materials, it is not a much of a stretch to expand to verification of nuclear material cycles to states possessing nuclear weapons. However, significant work will be needed to expand the model to the weapons, because national security requirements and Nuclear Non-Proliferation Treaty (NPT) Articles 1 and 2 commitments will impede the ability to provide many details. To-date, considerations regarding verification of nuclear materials and nuclear weapons disarmament verification have usually been addressed separately but the importance of these linkages have been recently presented (NTI 2014).

Applying the material pathway analysis to nuclear weapons-possessing states

For the purposes of developing the methodology, we will consider the verification of nuclear materials in a state possessing nuclear weapons that is subject to international commitments. It is assumed that an international inspectorate exists. It is important to remember that non-compliant behavior is defined as the violation of commitments so the legal situation or the assumptions must be taken into account. Two examples that we considered are:

- *Nuclear Weapons State (NWS) within NPT and Voluntary Offer Agreement (VOA).* A State having signed a VOA must not use the facilities under this agreement to produce material that will be used in a weapon.
- *State outside NPT and INFCIRC/66 in-force.* A State outside the NPT but with facility or item-specific commitments (INFCIRC/66 type agreements) must not use these facilities or items for military purposes.

Possible non-compliant behavior (edge types), in addition to clandestine processing, misuse of existing facilities, undeclared import and diversion from existing facilities

considered for NNWS would be included to account for the possible additional commitments beyond the NPT and IAEA safeguards. Depending on the commitments, clandestine processing (i.e. production in undeclared facilities) would not be part of the model because without a comprehensive agreement like in INFCIRC/153, states producing fissionable material in undeclared facilities would not be violating a commitment.

In states possessing nuclear weapons, two additional edge types could be considered: diversion from the military fuel cycle and military processing. These are illustrated in Figure 1.

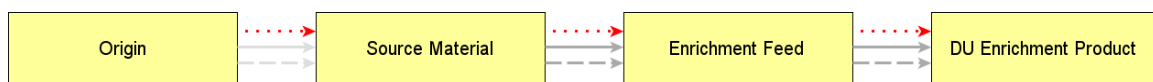


Figure 1: Example for a Cheating Path with additional edge types. Diversion from the military fuel cycle is represented by the red arrow from “origin” to “source material” and military processing is represented by all the remaining red arrows).

So, depending on the type of commitment, these processes could be carried out by the state without violating international law (e.g. in a INFCIRC/66 case but not if a multilateral treaty was in-force). When an activity is allowed, it would be represented in the model but the detection probability would be set at 0% because an allowed activity will not need to be monitored.

The methodology could be applied to three example scenarios:

1. A state with a complete military fuel cycle without safeguards but with the civilian facilities under safeguards. This could be under INFCIRC/66 or a VOA. In this case, where a military fuel cycle is allowed, the military pathways will remain the most attractive pathway for producing materials for weapons and therefore it is assumed that there will be no need for misuse or diversion from the declared civil fuel cycle. The risk of sanctions, if non-compliant behavior (such as pursuing a pathway that using civil installations under international surveillance) is detected would also deter misuse and possibly eliminate the need for an inspection effort at this pathway.
2. A case where some gaps/problems in military fuel cycle exist, they would be represented by missing diversion edges or reduced processing attractiveness values in the model. With effective verification, increased monitoring and verification could deter non-compliant behavior. So if State finds these pathways attractive, thereby violating its commitments, appropriate monitoring measures in those facilities, would increase the risk of detection. If the risk (and costs) of detection are high, the State should be deterred from non-compliant actions.
3. Military facilities & materials put under fissile material control regime. If military facilities and materials are put under a multilateral treaty, these

installations will be under the same restrictions as civil facilities under the NPT. Therefore there could be increased attractiveness to use these facilities for the production materials for nuclear weapons. To deter the use of these paths in violation of the commitments, the model would recommend a significant increased monitoring/inspection effort. The ability to verify a baseline declaration and knowledge of past production will be a key factor.

Applying the nuclear weapons pathway analysis to weapons-possessing states

To-date, consideration of monitoring and verification of weapons or weapons components has been in the context of specific treaties or during negotiations of possible new regimes. In applying a state-level methodology to weapons, and developing the appropriate CPs, it will be important to consider the strategic objectives of a state. The CPs could be different if the objective is to expand the size of the national stockpile or to increase the degree of technical sophistication of their stockpile. Some potential cheating pathways include warheads or weapons that were not included in baseline declarations, diversion of materials or components from dismantlement, and undeclared production of warheads. Ways to link monitored nuclear material and facilities with warhead production & dismantlement will need to be considered to achieve confidence that new production is not occurring.

NTI (2014) has worked to advance methods to verify material and warhead baseline declarations in states possessing nuclear weapons. The confidence in these declarations will be key to modeling an effective monitoring/verification regime that could detect clandestine activities.

One option to begin modeling the weapons complex would be to use IAEA Physical Models and indicators and modified them as appropriate. There will also be a need to consider weaponization indicators, to take into account possible reconstruction of existing warhead designs without use of development/testing facilities as well as acquisition of a weapon or development of more sophisticated weapons.

Further considerations

The development of a state-level approach to modeling material CPs is more advanced than for weapons, but work can be done to further expand the models and make the linkages between material and weapons cycles. The challenges associated with the protection of national security and nonproliferation information must be taken into account as a realistic physical model is developed. Existing ideas for managing access for routine and challenge inspections or new ideas will need to be considered. Lessons learned from U.K.-Norway exercise should be applied.

Any advancement in arms reductions and disarmament is likely to proceed in a step-by-step way. Bilateral agreements are likely to provide the steps that will pave the way for

more multilateral implementation. For example, future US/Russia disarmament treaties limiting warhead numbers may build the infrastructure for facility monitoring and inspection activities, and India/Pakistan transparency and confidence-building measures may provide capital for more intrusive monitoring activities. Such a state-level methodology could help inform the direction of future negotiations, present day technology R&D, and assessment of possible effective verification regimes.

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